F/A-18 Replacement Umbilical Qualification Testing

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
	Viewgraphs	

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
F/A-18 Replacement Umbilical Qualification Testing	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)	5d. PROJECT NUMBER
Susan Jahn Greg Miller	5e. TASK NUMBER
	5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)	8. PERFORMING ORGANIZATION REPORT NUMBER
Naval Air Warfare Center Aircraft Division 22347 Cedar Point Road, Unit #6 Patuxent River, Maryland 20670-1161	

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
Naval Air Systems Command 47123 Buse Road Unit IPT Patuxent River, Maryland 20670-1547	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT

Approved for public release; distribution is unlimited.

13. SUPPLEMENTARY NOTES

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			Susan Jahn / Greg Miller
Unclassified	Unclassified	Unclassified	Unclassified	27	19b. TELEPHONE NUMBER (include area code) (301) 342-4339 / 342-4313

DEPARTMENT OF THE NAVY
NAVAL AIR WARFARE CENTER AIRCRAFT DIVISION
PATUXENT RIVER, MARYLAND 20670-5304

5200
721200A/1326
24 March 2000

From: Team Leader, Visual and Technical Information Team, Naval Air Warfare Center Aircraft Division, 22133 Arnold Circle, Patuxent River, Maryland 20670-1551

To: Administrator, Defense Technical Information Center, 8725 John J. Kingman Road, Suite 0944, Fort Belvoir, VA 22060-6218

Subj: SUBMITTAL OF SCIENTIFIC AND TECHNICAL INFORMATION

Encl:
(1) Tribological Limitations in Gas Turbine Engines
(2) Status of U.S. Navy Ship Airwake CFD Efforts
(3) Source Code Overlay Editor
(4) Toward Validating a Generic Rotorcraft Model Structure
(5) The Impact of Acquisition Issues and Training on Test and Evaluation
(6) Finishing Systems for Naval Aircraft Applications: Current Schemes and Future Trends
(7) Systems Engineering Management Training at Naval Air Systems Command
(8) High Fidelity Installed Sensor Testing Using an Infrared Scene Projector
(9) Multi-Place Lift Raft Improvement Program Photographs
(10) The ACETEF HLA Interface
(11) Failure Analysis of Composite Bonded Joints
(12) Development of Real Time Ultrasonic Imaging
(13) Joint Test and Training Capability Assessment (JTTCA)
(14) New Multi-Place Life Rafts a Jump in Time for the U.S. Navy
(15) Establishing a Software Cost Estimating Process
(16) Lessons Learned from Utilizing PEM's in a Flight/Safety Critical System
(17) Mid-Atlantic Area Frequency Coordination Office (Slides)
(18) Joint Navy and Air Force Infrared Sensor Stimulation (IRSS) Program for Installed Systems Test Facilities (ISTF's)
(19) Tail Rotor Flapping
(20) Evaluation of Hydrogen Peroxide Activated Paint Strippers
(21) Time Accurate Computational Simulations of Ship Air Wake
(22) Development and Testing of the F/A-18 Replacement MIL-STD-1760 Umbilical
(23) Environmentally Influenced Near-Threshold Fatigue Crack Growth in 7075-T651 Aluminum Alloy
(24) Comparison of AEDC 4T and Calspan 8-ft Wind Tunnels for FA-18C/JDAM
(25) Current USN/USMC Aircraft Anthropometric Compatibility Issues and the "Street to Fleet" Proposal
(26) Establishing a Program for Applying Earned Value Metrics to Flight Test
(27) Microdoppler: NonCooperative Target Classification/Identification
(28) The Effect of Aircrew Age on +Gz Tolerance as Measured in a Human-Use Centrifuge
(29) F/A-18 Replacement Umbilical Qualification Testing

(30) ACETEF Participation in JADS EW (Videotape)
(31) 1760 Umbilical Ejection Stand Tests (Videotape)
(32) Flight Test Team Video
(33) The Naval Air Pacific Repair Activity: Making Memories (Videotape)

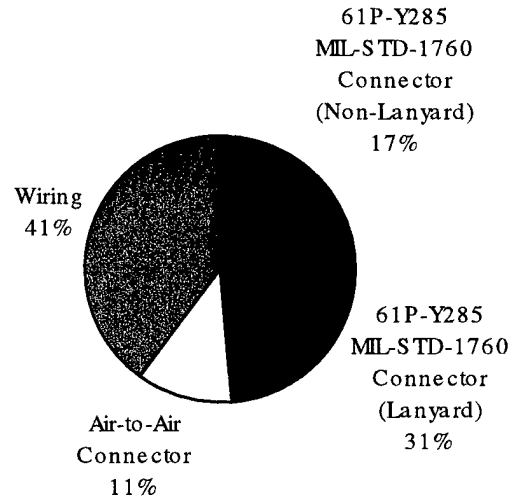
1. Enclosures (1) through (28) are forwarded for retention.

2. Please contact Tonya Bunker at (301) 342-1709 should you have any questions.

Karen L. Jensen
KAREN L. JENSEN
Acting

Background

- Existing umbilical designed for AWW-13
- Doesn't Fit well with existing weapons
- Umbilical failures during certification/integration testing
- Replacement cable required



Qualification Test Program

- Fit
- Electrical Compatibility
- Static Pull
- Static Ejection
- E3 (EMC/EMI/EMV, HERO, Lightning)
- Environmental
- Captive Carriage (Post-release configuration)

Lightning Test Requirement

- The lightning threat scenario at issue:
  - A direct strike to the nose of the weapon, transmitted through the weapon to the aircraft via current paths (including the cable), traveling through the aircraft and exiting the tail of the aircraft.
  - Direct lightning strikes were not considered to be a threat for this cable due to the cable location within the pylon bay and weapon attachment point.
  - Concern was the ability of the composite components of the cable to withstand and remain functional when exposed to direct lightning effects as a major current path
  - Indirect lightning effects are considered less severe and answerable by the direct effects issue.

Lightning Zone and Test Parameters

- Determined to be Zone 3
  - Umbilical is a major current path for the lightning to traverse from the weapon to the aircraft
  - Other Major current paths (for a total of 5 paths):
    - Forward swaybrace and ejector foot units
    - Aft swaybrace and ejector foot units
    - Forward Lug/Hook Interface
    - Aft Lug/Hook Interface
  - To provide a conservative simplifying assumption, all current paths are assumed of equal impedance, but all paths applied.
- Waveforms for Zone 3 tests --"ABCD" of MIL-STD-464 Figure 1.
- The Umbilical is considered mission critical equipment and required to be tested to full threat levels.
  - Documented lightning strike history of F/A-18 shows required avionics for store release would typically be functional after a lightning strike
  - Cable should not be permitted to be the failing item.

Lightning Test Parameters

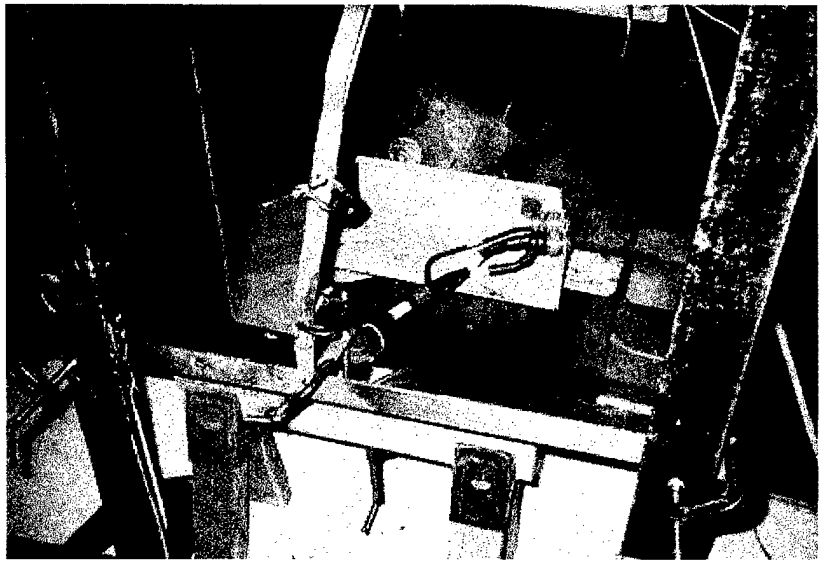
- The cable was required to be subjected to the following lightning indirect effects waveform parameters (MIL-STD-464 Figure 1 parameters, full threat level, divided by 5 equal current paths):

Current Component	Description	Current Waveform Parameters			
		Amplitude	Action Integral	Charge Transfer	Time
A	Initial Stroke	200,000÷5=**40,000 A Peak ±10%**	2×10^6 A^{2}s ±20%	–	<500 µsec
B	Intermediate Current	2000.÷5= **400 A Avg ±10%**	–	10÷5= **2 Coulombs Max**	<5 msec
C	Continuing Current	(200 to 800)÷5=**40 to 160 A Avg ±20%A**	–	200÷5= **40 Coulombs +/- 20%**	0.25 sec<T<1 sec
D	Restrike	100,000÷5=**20,000 A Peak ±20%**	0.25×10^6 A^{2}s ±20%	–	<500 µsec

Pass/Fail Criteria

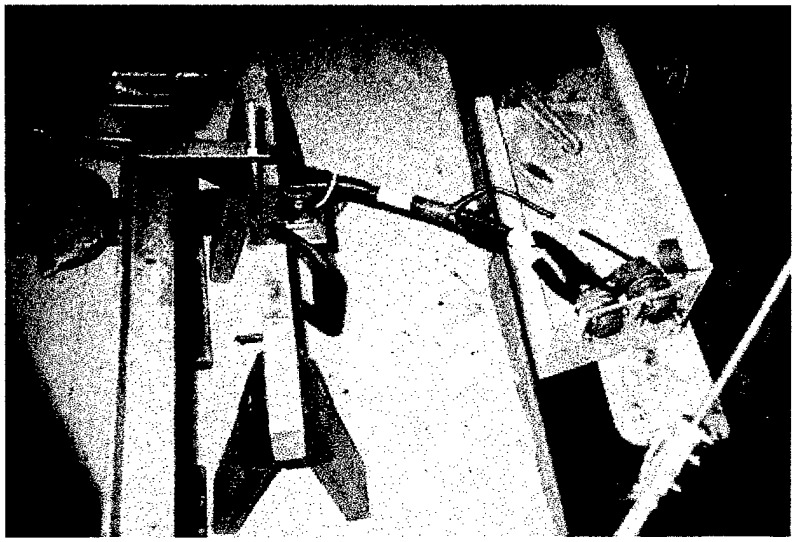
- Must remain physically and functionally intact to support continued carriage after the strike and employment or downloading of the weapon.
  - Due to the nature and low cost of the cable, reuse of the cable on subsequent missions is desired, but not required.
  - The Lanyard release connector must separate from the simulated weapon receptacle with reasonable pull force (hand pulled)
  - The A/A, A/G, and video connectors are desired, but not required, to be readily removed (not fused) from their mated receptacles.
  - Cable must retain continuity through signal paths, with no induced shorts.
  - Damage to shielding will be evaluated based on its impact to the ability to employ the weapon with degradation measured from pre-test baseline levels (test/cable tolerance assumed to be 5 dB).
  - Other damage will be evaluated on the basis of its impact to weapon employment.
  - If damaged, prefer visible indications.

Lightning Setup



Umbilical installed in fixture and attached to 4 in x 4 in x3/4 in plate with receptacle.

Lightning applied through rod to plate.



Lightning Tests

- Whoops! On first event Waveform C failed to turn off. Conservative estimates of >300 Coulombs applied (vice 40 Coulombs +/- 20% test requirement)
- Other Test Events occurred normally
- Preliminary Results - All Cable/Connectors showed satisfactory performance

Captive Carriage Tests

- Post-Release Configuration
- 1 Flight with specific maneuvers
- Additional flight to collect flight time (approx. 20 hrs)
- 4 Umbilicals
  - 2 completed 100 releases
  - 1 completed 58 releases
  - 1 new

Static Pull Tests

- 6 New MIL-C-38999/31 Connectors static pull tested
  - to assure the connector type complies with separation requirements
  - to obtain a pull force baseline for in specification pull angles and out of specification pull angles to support ejection test stand and future store separation tests.
- Each connector was pulled 10 times at 0, 5, 10, and 15 deg (within specification pull angles) and then as time permitted 16 deg to 25 deg (beyond specification pull angles).
- Receptacle replaced every 5 pulls
- Lanyard Orientation Varied
- Fixed Pull Rate of 1.6 in/sec
- Pull Force Measured
- Video

Ejection Tests

- Tests still in progress
- Tests store separation from a test stand to assess umbilical service life performance.
  - 6 Prototype Umbilical Cables
  - 100 times each
- Locally developed variable CG Test store used for tests
  - CG changed from (15 to 30 in afl) to vary pull angle and rate
  - 2 Receptacle Positions (9 and 15 in aal)
- High Speed Video

DOD-C-38999/31

Durability:

No release force measurement required
Lanyard release velocity during pull-separation of
9.15m/s = 30.02 ft/s = 360 in/s

Pull separation force:

400 N (90 lbf) max force for straight pull
445 N (100 lbf) max for for 15° pull
Pull rate not exceeding 13 cm/s = 0.426 ft/s = 5.12 in/s

Our Tests:

Ejection test was between 6.25 ft/s=75 in/s and
11.25 ft/s=135 in/s
Static test was at 1.6 in/s

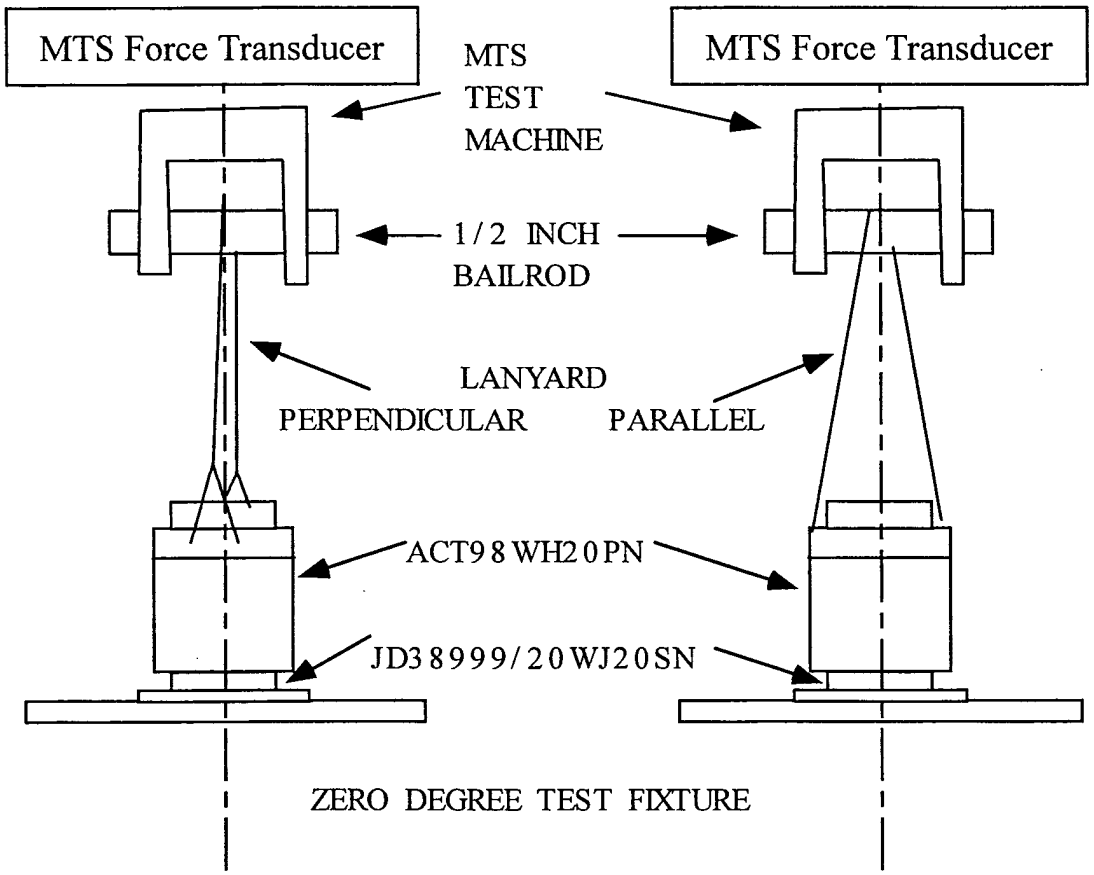
DOD-C-38999/31

"Durability: Wired connectors shall meet the durability requirements of MIL-C-38999, with the following exception:

The total number of cycles of mating and unmating shall be 500, in the following sequence: 200 cycles of normal mating and unmating, 50 cycles of normal mating with pull-separation unmating, 200 cycles of normal mating and unmating, and 50 cycles of normal mating with pull-separation unmating. The lanyard release velocity during the pull-separation unmating cycles shall be 9.15 m/s.

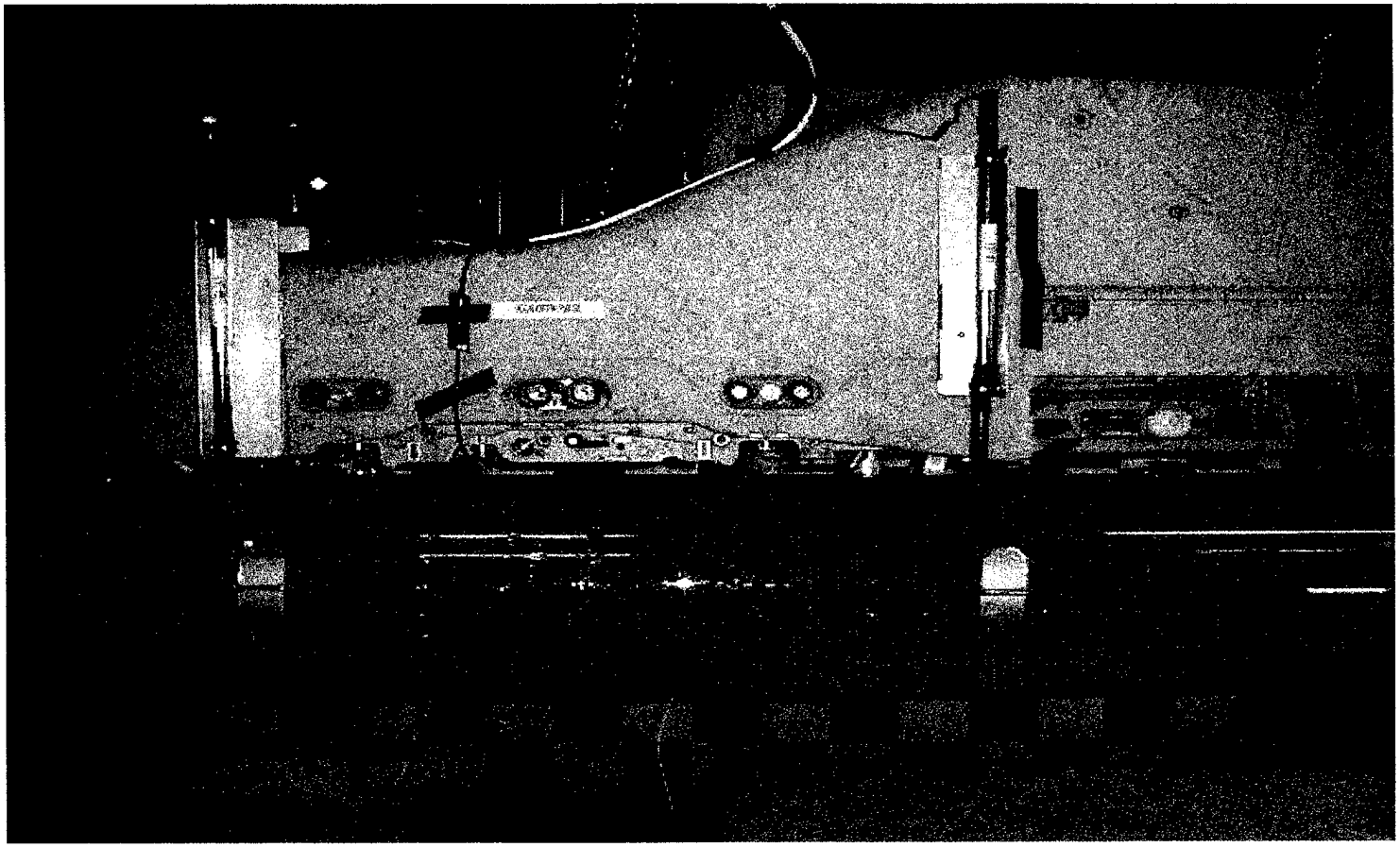
Pull-separation force: In addition to mating and unmating by normal coupling ring rotation, the connector shall be capable of lanyard-pull separation at any angle within 15 degrees of the normal axis. Each connector shall have one straight pull and one pull at 15 degrees from straight, with a pull rate not exceeding 13 cm/s. The test will be at -65°C, at ambient, and at the maximum temperature of the specified class. The test will be conducted within three minutes after removal from the temperature chamber without forced heating or cooling. Maximum separation forces shall be 400 newtons for a straight pull and 445 newtons for a 15 degree pull."

Static Test Setup



COMPOSITE MIL-STD-1760 LANYARD CONNECTOR STATIC TEST SET-UP

Ejection Test Setup



3 L.V.T.'s

Cable Electric Disconnect

Hooks Open Pulse

Bail Bar Strain Gage

Measurement Definition

Pull Angle

Angle defined by the line perpendicular to the horizontal plane of the connector clockwise to the line made by the lanyard from the attach point on the connector to the bail bar using the film/video frame prior to the frame showing connector/receptacle separation.

Measurement Definition

Pull Rate

Static Test - Constant velocity preset as the speed of the MTS test machine.

Ejection Test - Velocity calculated using the aft Linear Velocity Transducer at the time indicated by electrical disconnect.

Measurement Definition

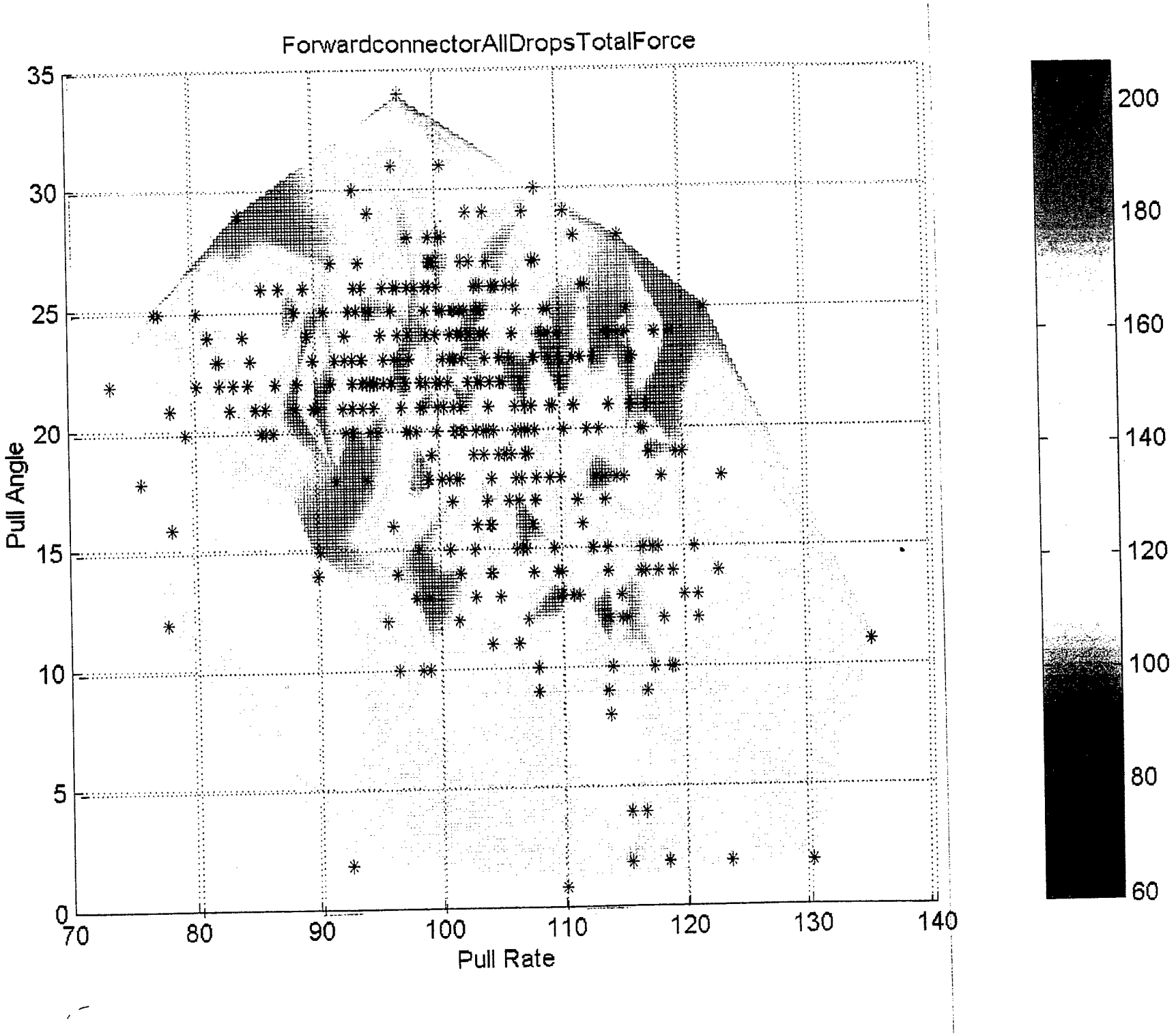
Pull Force

The peak force that was measured as the connector separated from the receptacle.

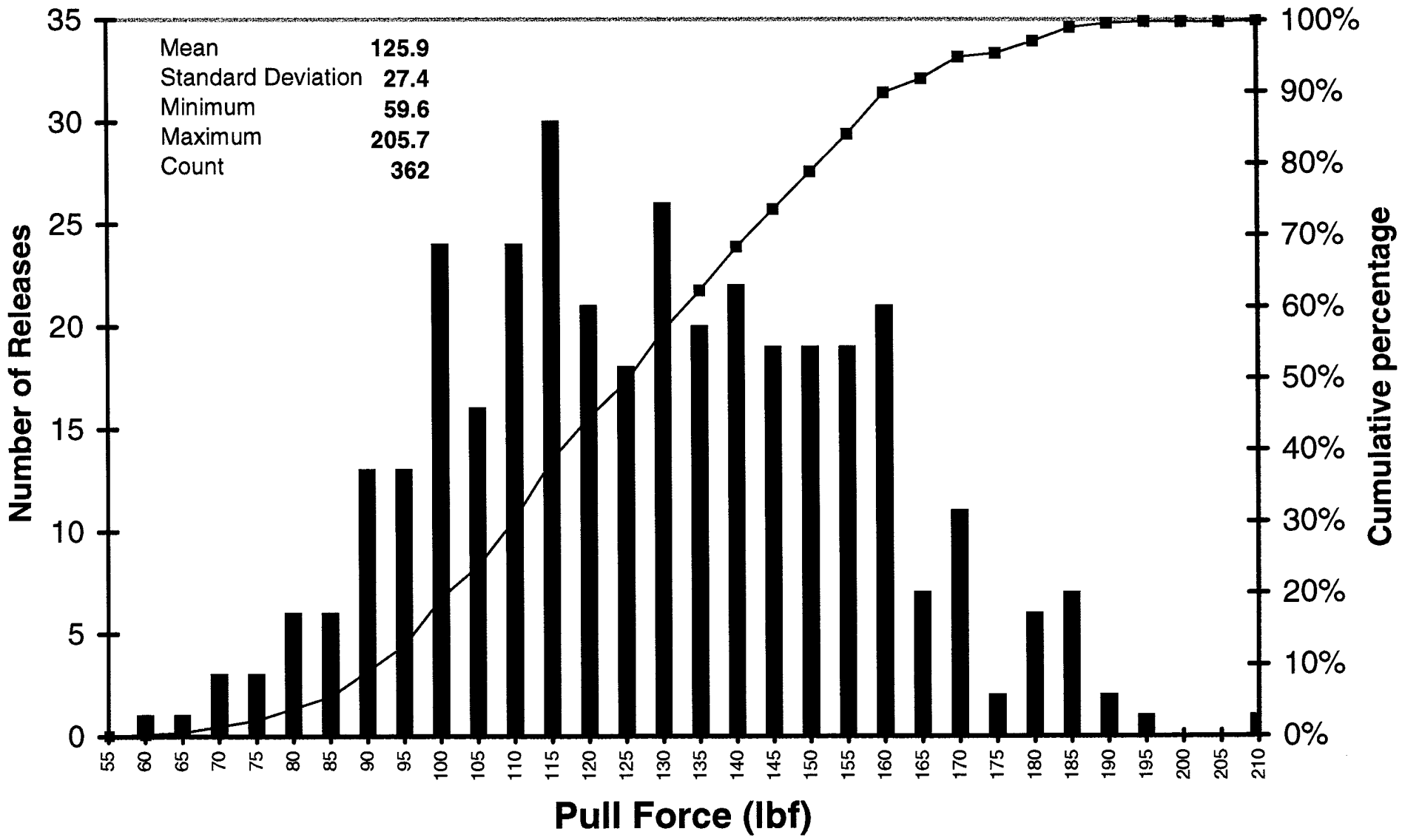
Static Test - Measured using a force transducer attached to the MTS machine. 1000 lbf range used.

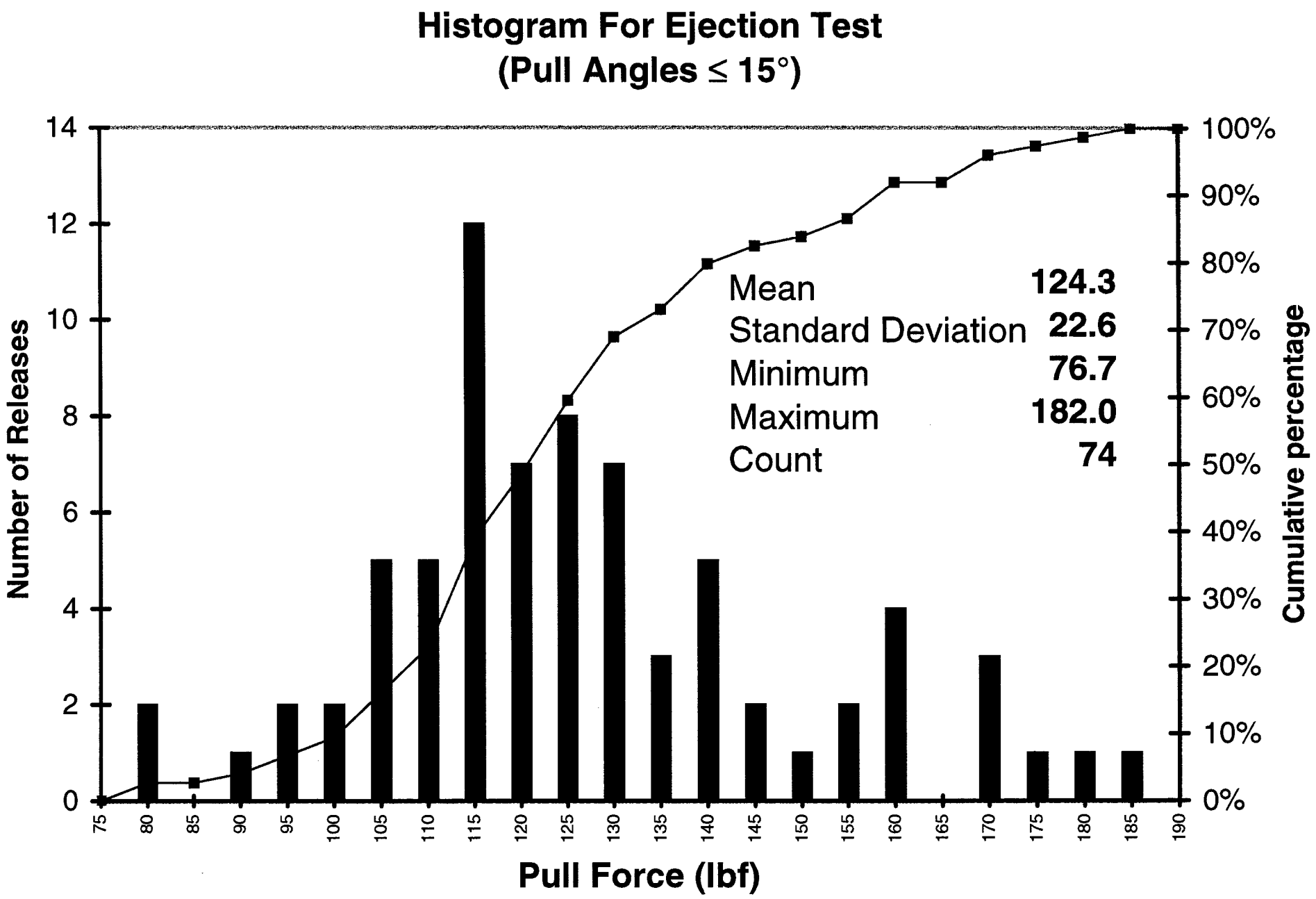
Ejection Test - Measured bail bar deflection using bridge strain gage configuration. Bail bar calibrated to 300 lbf.

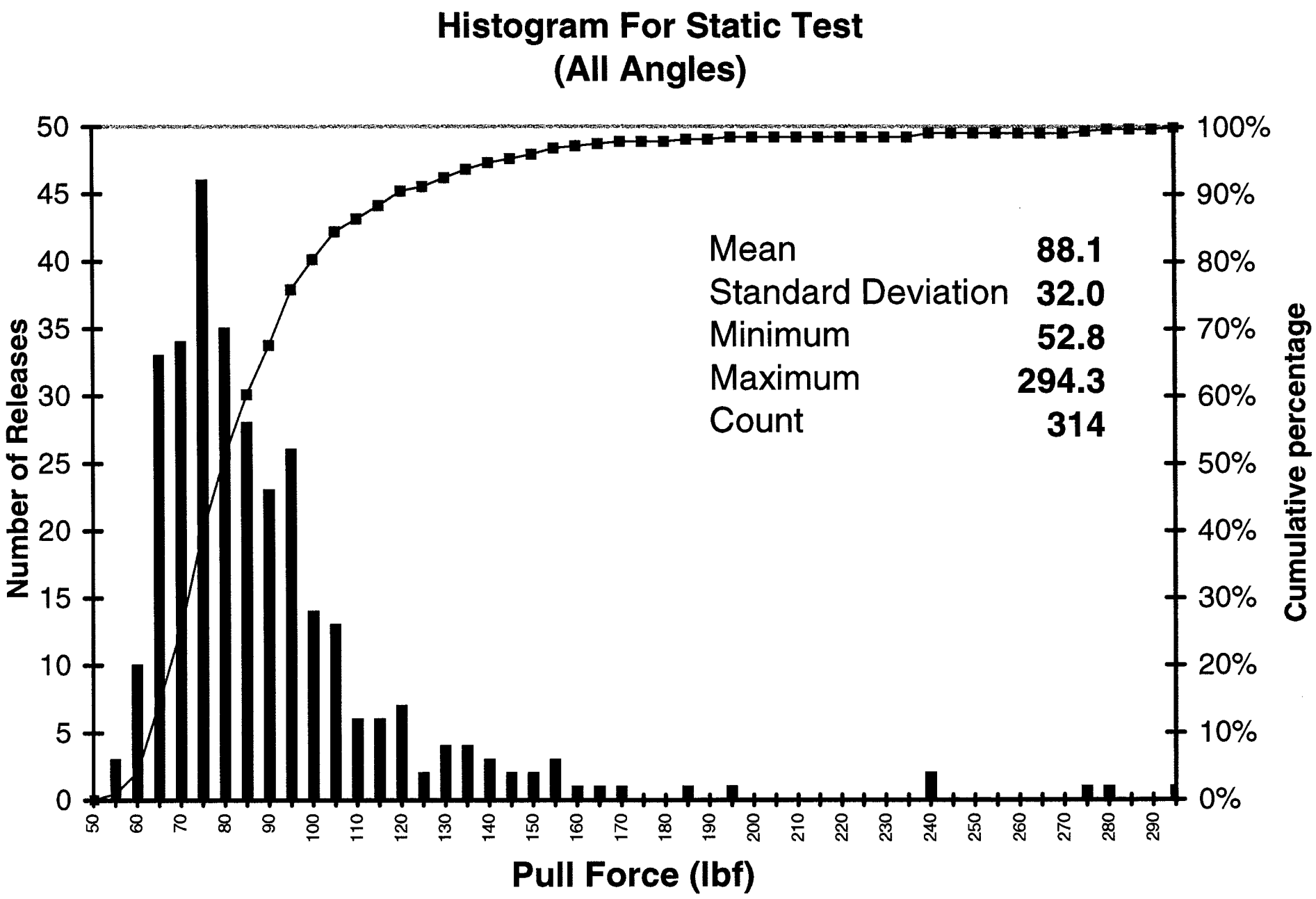
Other measurements were taken that related to safety and test conduct.

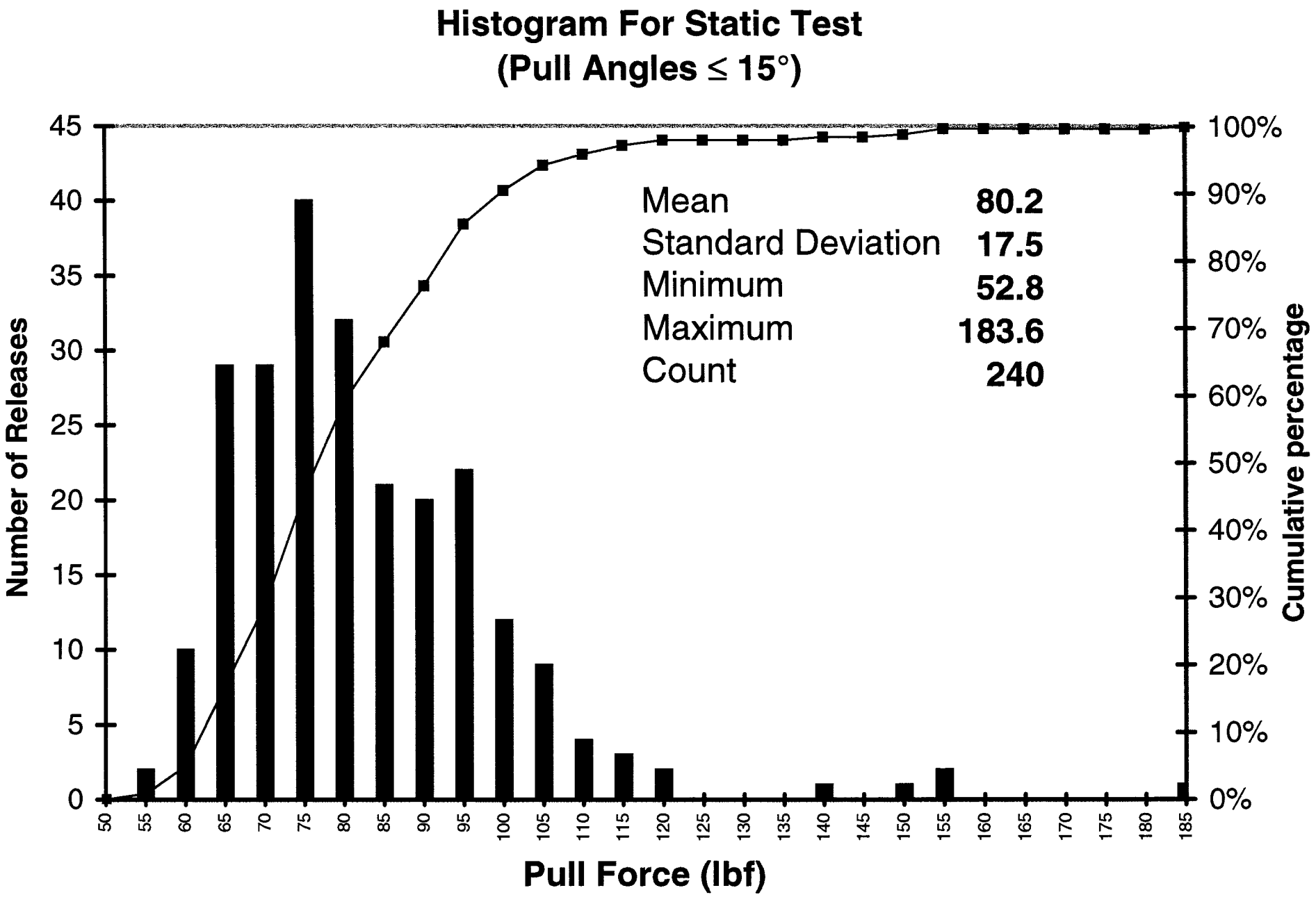

ForwardconnectorAllDropsTotalForce
Pull Angle
Pull Rate
35
30
25
20
15
10
5
0
70
80
90
100
110
120
130
140
200
180
160
140
120
100
80
60

Histogram For Ejection Test
(All Drops, Forward Receptacle)

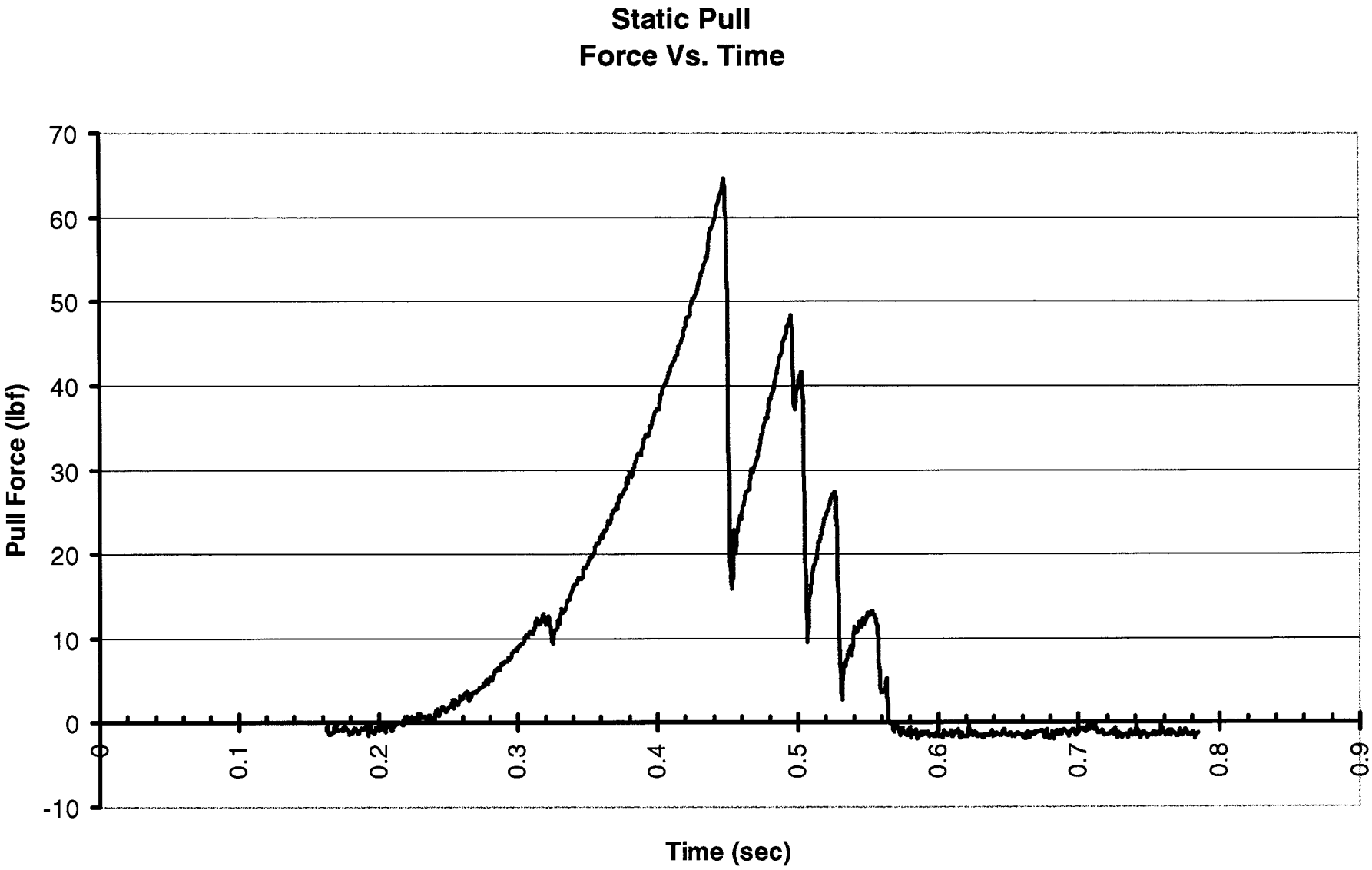



Histogram For Ejection Test
(Pull Angles ≤ 15°)
Number of Releases
Cumulative percentage
Pull Force (lbf)
Mean 124.3
Standard Deviation 22.6
Minimum 76.7
Maximum 182.0
Count 74
0
2
4
6
8
10
12
14
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
75
80
85
90
95
100
105
110
115
120
125
130
135
140
145
150
155
160
165
170
175
180
185
190

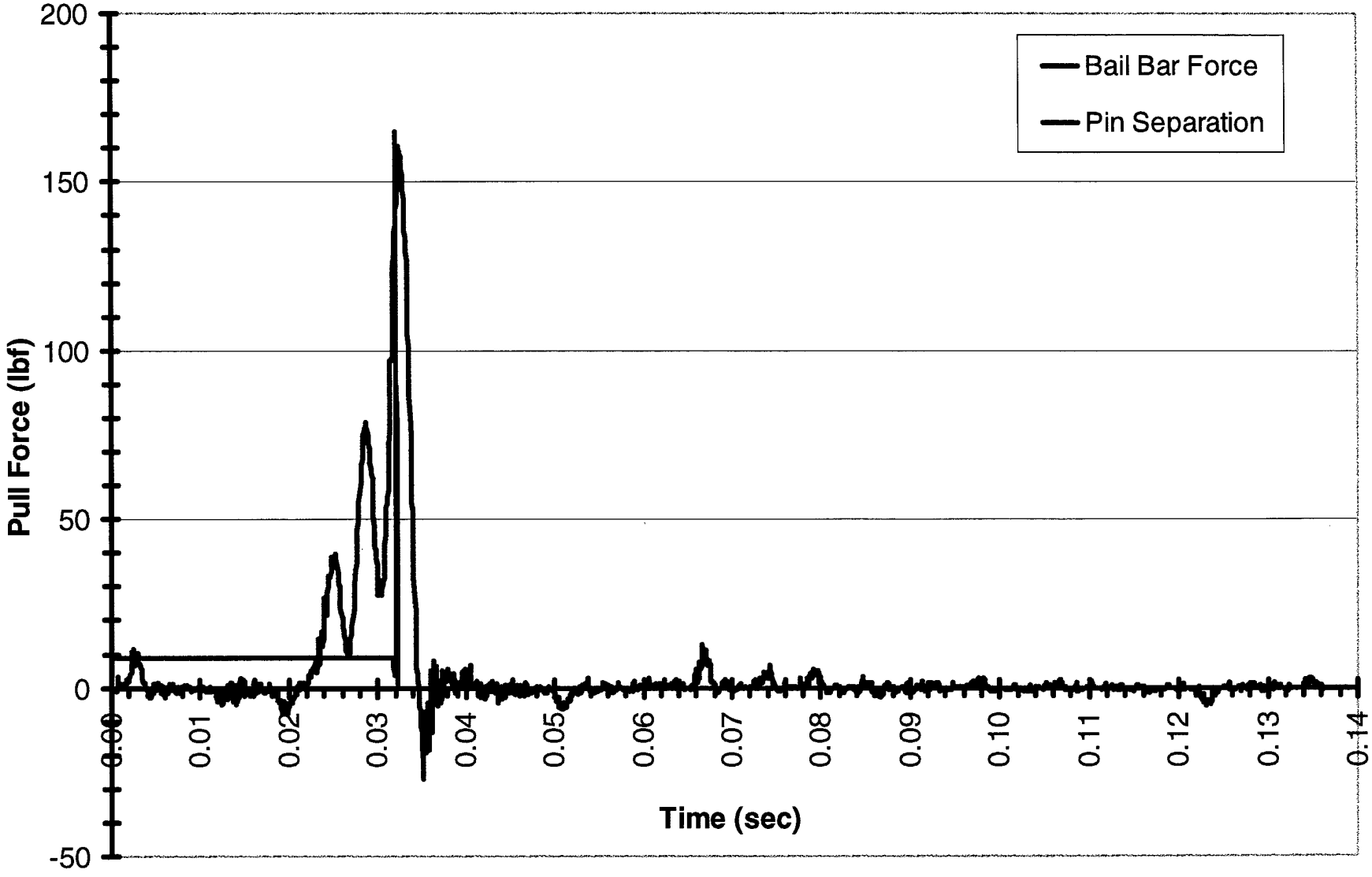

Histogram For Static Test
(All Angles)
Number of Releases
Cumulative percentage
Pull Force (lbf)
Mean 88.1
Standard Deviation 32.0
Minimum 52.8
Maximum 294.3
Count 314
0
5
10
15
20
25
30
35
40
45
50
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230
240
250
260
270
280
290


Histogram For Static Test
(Pull Angles ≤ 15°)
Mean 80.2
Standard Deviation 17.5
Minimum 52.8
Maximum 183.6
Count 240
Number of Releases
Cumulative percentage
Pull Force (lbf)
0
5
10
15
20
25
30
35
40
45
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
50
55
60
65
70
75
80
85
90
95
100
105
110
115
120
125
130
135
140
145
150
155
160
165
170
175
180
185

Example Pull Force vs. Time plots



Example Pull Force vs. Time plots



Example Pull Force vs. Time plots